BIOMECHANICAL ANALYSIS OF HIP IMPLANT REFIXATION PROCEDURE

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INTRODUCTION

Loosening of orthpaedic hip prostheses is an increasig health problem. In eldery patients with comorbidity, revision surgery may lead to high mortality rates. A less invasive procedure that involves percutaneous gene therapy, designed to destroy the periprosthetic loosening membrane, and subsequent refixation of the hip prosthesis with percutaneous bone cement injections under radiological guidance was described earlier by de Poorter *et al.* [1].

In this work we use fintie element modelling to analyse the effectiveness of the above procedure by comparing the implant stability, cement wear and cement stress state before and after cement injection.

METHODS

We reconstructed the geometry of a femur from CT images and used preoperative planning software to virtually place a hip implant. The geometry of the cement mantle was generated based on a standard cement fixation procedure under supervision of a skilled surgeon. Geometries of three periprosthetic fibrous membrane areas, located around the cement mantle, were also generated based on the locations of osteolytic areas, as described by Garcia-Cimbrelo *et al.* [2] (Fig. 1).

Three detailed finite element models of the implanted hip with different fibrous membrane configurations were created. In order to simulate the mechanical environment before and after cement injection we ran the simulations with the stiffness of the osteolytic areas set first to fibrous tissue stiffness and then to cement stiffness values. The distal part of the models was fixed, while the implant head was loaded with 800N force, mimicking one body weight. We assumed contact condition between the cement mantle and the bone, while the fibrous membrane and, subsequently, newly injected cement were assumed to be bonded to the bone and the old cement. Archard's model was used to simulate cement wear.

RESULTS AND DISCUSSION

Injection of cement into the area, previously occupied by fibrous membrane significantly contributed to the reduction of bone/cement relative motions (Fig. 2, left) which could potentially cause pain reduction observed clinically by de Poorter *et al.* [1]. The reduction of the simulated wear was noticeable, but only moderate (Fig. 2, right), suggestion that the produced wear debris could be the reason for the osteolysis postoperatively. The procedure also caused relaxation of the peak cement stresses, which could contribute to the reduction of damage accumulation inside cement mantle.

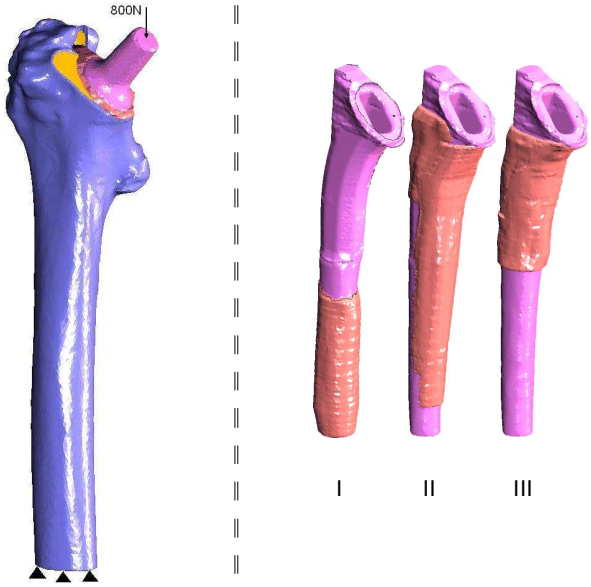

Figure 1: *Left*: Geometry and boundary conditions of the model; *Right*: three configurations of the fibrous tissue membrane around the cement mantle.

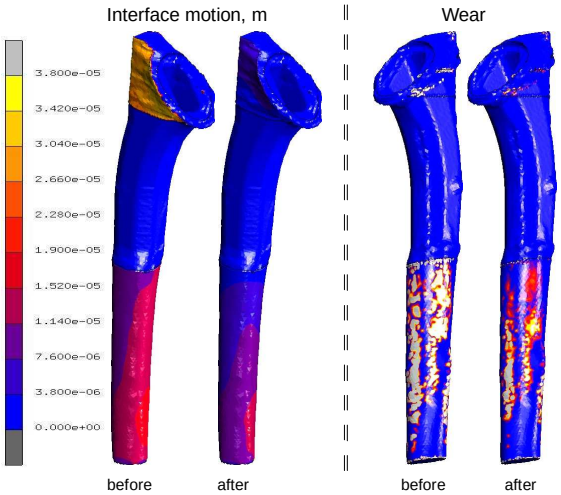

Figure 2: Interface motion and cement wear before and after cement injection for the membrane configuration III.

CONCLUSIONS

Cement injection can have a positive influence on stability and longevity of cemented hip implants.

REFERENCES

1. de Poorter, J.J, et al, *Human Gene Therapy*. **19**: 83-96, 2008
2. Garcia-Cimbrelo, E., et al, The J. of Arthroplasty, **12**: 624-634, 1997